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Challenges for Management of the Fisheries Resources, Biodiversity and Environment of Lake Victoria

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Fisheries Resources Research Institute

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4.3. Management of the Nile perch, *Lates niloticus* fishery, in Lake Victoria in light of the changes in its life history characteristics

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Introduction

Nile perch, *Lates niloticus* Linnaeus, 1758, is a predatory fish of high commercial and recreational value. It can grow to a length of 2 m and a weight of 200 kg. In Uganda, Nile perch was originally found only in Lake Albert and the River Nile below Murchison Falls. The species is, however, widely distributed in Africa, occurring in the Nile system below Murchison Falls, the Congo, Niger, Volta, Senegal and in Lakes Chad and Turkana (Greenwood 1966).

The distribution of Nile perch was extended through introduction of the species into Lakes Kyoga, Nabugabo and Victoria from Lake Albert during the 1950's and early 1960's. Eight specimens from Lake Turkana were introduced in the Kenyan part of Lake Victoria at Kisumu in 1963 (Gee 1964). The purpose of introducing Nile perch into Lakes Victoria and Kyoga was for it to feed on the small-sized haplochromine cichlids, which were at that time abundant, but not much exploited, and convert them into a larger fish of greater commercial and recreational value (Graham 1929; Worthington 1929; Anderson 1961). There were, however, fears that Nile perch might deplete stocks of native commercial fish species including itself after which the fisheries would collapse.

Stocks of Nile perch increased rapidly after 1965 in Lake Kyoga, and after 1977 in Lake Victoria. This was followed by rapid increases in fishery yield (Hughes 1983, Okaronon *et al*.,1985, Goudswaard and Witte 1985). Increased abundance of Nile perch was accompanied by a reduction and, in some cases, total disappearance of many of the native species (Ogutu-Ohwayo 1990a, b; Ogari & Dadzie, 1988; Ligtvoet & Mkumbo 1990). Haplochromines, which were the most abundant fishes in Lake Victoria and were expected to form the bulk of the food of the Nile perch, were depleted and other species became scarce. About 60% of the haplochromine species are thought to have become extinct (Witte *et al*.,1992a, b). The food of the Nile perch changed to the extent that it started feeding on its

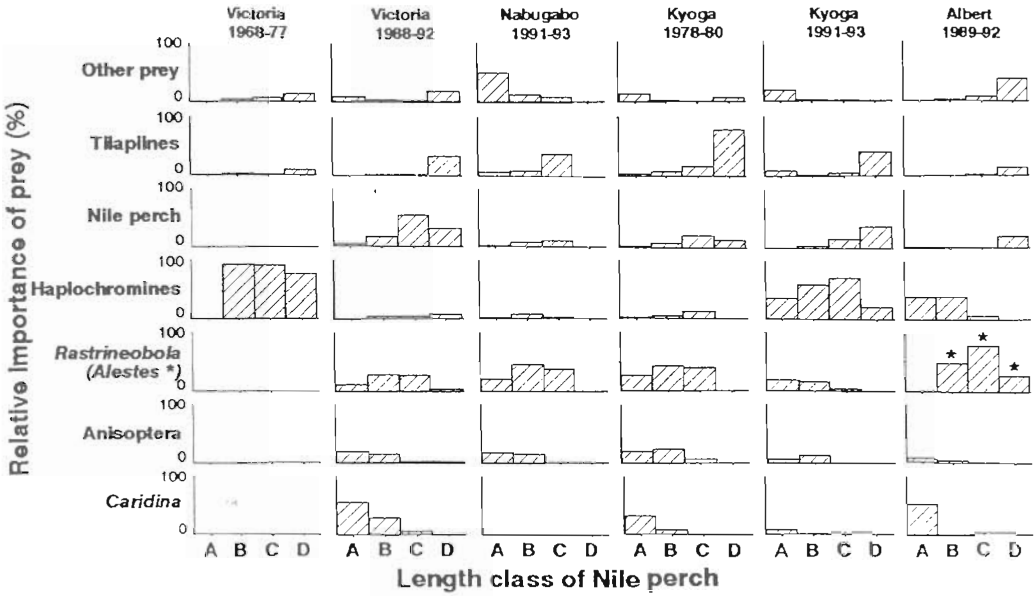

Fig. 4.3.1. The relative importance of prey eaten by Nile perch in of: A<20; B, 21 to 59; C, 60 to 100 and D >100 cm Lakes Victoria, Kyoga, Nabugabo and Albert during the different periods.

Between 1968 and 1977 haplochromines were the dominant prey of most sizes of Nile perch in Lake Victoria. By 1988, the major types of prey eaten in Lake Victoria had changed to *C. nilotica*, anisoptera nymphs, Nile perch juveniles, tilapiines with very few haplochromines. These remained the major types of prey eaten by Nile perch in Lake Victoria up to the 1995 - 2000 period when the proportion of haplochromines eaten increased (Fig. 4.3.2). The contribution of haplochromines was, however , still lower than the situation during the 1968-77 period. *C. nilotica*, anisoptera nymphs, *R. argentea* and Nile perch juveniles were the most important prey of Nile perch of less than 60 cm. Nile perch of 60 to 100 cm ingested mainly *R. argentea* and Nile perch juveniles while those of more than 100 cm still ate mainly tilapiines and Nile perch juveniles.

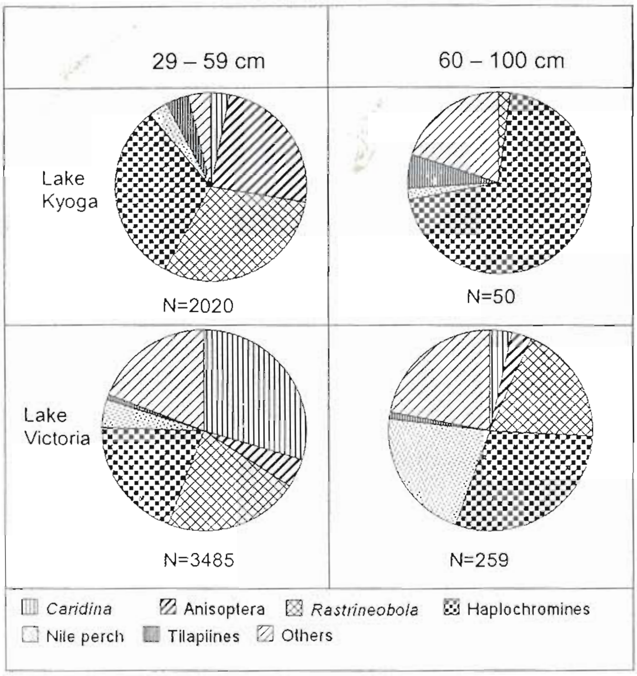

Fig. 4.3.2. The relative importance of prey eaten by Nile perch of 20 to 100 cm in lakes Victoria and Kyoga between 1995 and 2000.

In Lake Albert, the reference habitat for Nile perch, the most important prey were *Alestes* spp, haplochromines, *C. nilotica*, anisopteran nymphs and Nile perch juveniles. *C. nilotica* and haplochromines were important in Nile perch of less than 20 cm. Nile perch of 20 cm to 60 cm ate Alestes spp, haplochromines, anisopteran nymphs, and *C. nilotica* while those of 60 cm to 100 cm fed on *Alestes* spp, haplochromines, *Hydrocynus* spp, Nile perch juveniles and tilapiines. Nile perch of more than 100 cm ate a variety of fish prey which included *Alestes* spp, juvenile Nile perch, P*olypterus senegalensis*, mormyrids and *Bagrus* spp.

From the above studies, it can be concluded that the main prey of Nile perch in Lakes Victoria, Kyoga, Nabugabo and Albert are *C. nilotica*, anisopteran nymphs, *R. argentea* or *Alestes* spp, haplochromine species, tilapiine species and Nile perch juveniles. *C. nilotica* are, however, more important and are eaten by Nile perch of a wider size range (up to 100cm) in Lake Victoria than in the other lakes. Anisopteran nymphs were more important in Lakes Kyoga and Nabugabo than in Victoria and Albert.

R. argentea, for Lakes Victoria, Kyoga and Nabugabo, and *Alestes* spp, for Lake Albert, were, in the absence of haplochromines, the most important fish prey species of Nile perch in the four lakes. *R. argentea* was very important for Nile perch of 20 cm to 100 cm in Lakes Victoria, Kyoga and Nabugabo, while in Lake Albert, Alestes spp were important in Nile perch >20 cm. A decline in the importance of haplochromines was followed by increased dependency on *R. argentea*. However, as haplochromine stocks improved, Nile perch reverted to feeding more on haplochromines suggesting that Nile perch shifts to *R. argentea* only in the absence of haplochromines suggesting that *R. argentea* is a less preferred prey than haplochromines.

The length and numbers of prey ingested

The length and number of prey eaten changed with the size of the predator for all the periods examined (Fig. 4.3.3). The most abrupt change in both number and the size of prey eaten occurred in Nile perch of about 100 cm total length. This was most abrupt following a decline in haplochromine prey.

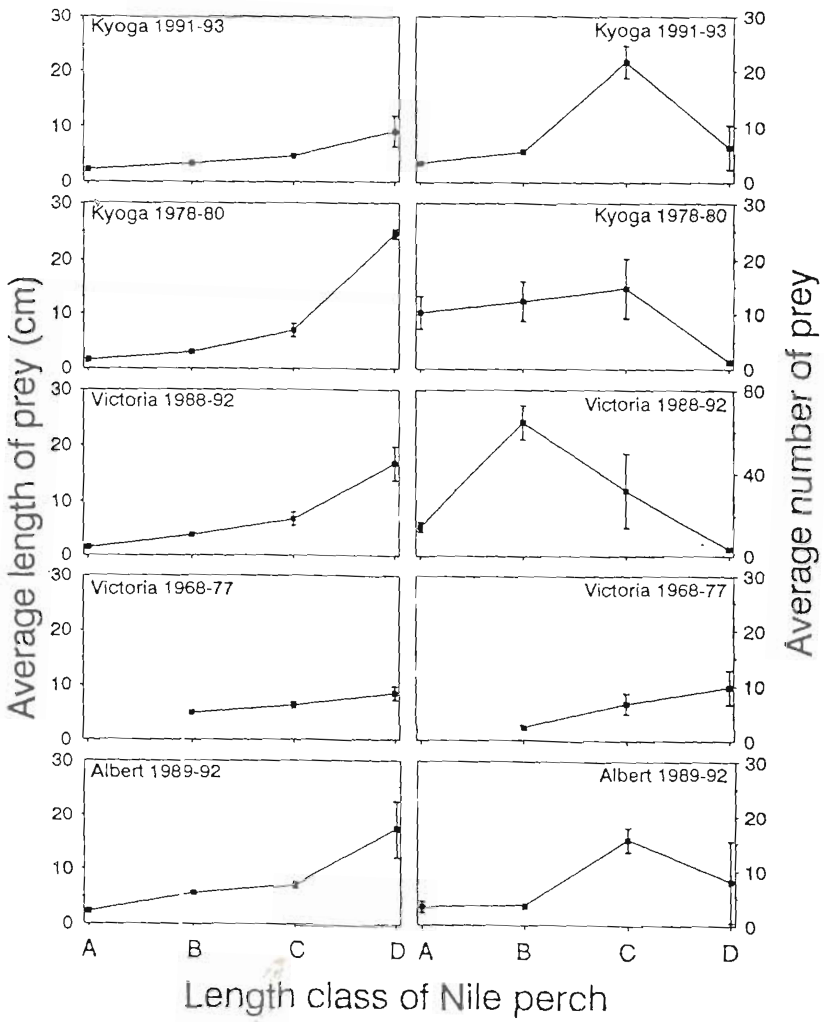

Fig. 4.3.3. The average length and numbers of prey eaten by Nile perch of: A, <20cm; B, 20 to59; C, 60-100 and D, >100.

In Fig. 4.3.4, the changes in the average sizes and numbers of prey eaten by Nile perch of >100 cm in the new habitats from the time when haplochromines were still abundant through the period when haplochromine stocks had virtually disappeared to that when they had started to recover are compared with data from Lake Albert for the period 1989 to 1992. From 1968 to 1977, the average length of prey taken by Nile perch of more than 100 cm in Lake Victoria was lower than that for Lake Albert while the average number was higher. After this period, the average number of prey decreased while the average length increased. Eventually, the average number became lower than in Lake Albert while the length increased beyond that found in that lake. By the 1978-1998 period, the average length of prey had increased beyond the values recorded in Lake Albert while the average numbers had declined to lower values. With the improvement in haplochromine stocks as demonstrated by the 1991 - 1993 data from Lake Kyoga, the average length of prey eaten declined while average numbers increased towards values recorded in Lake Albert. This shows that Nile perch meets its food requirements by increasing either the number or size of prey.

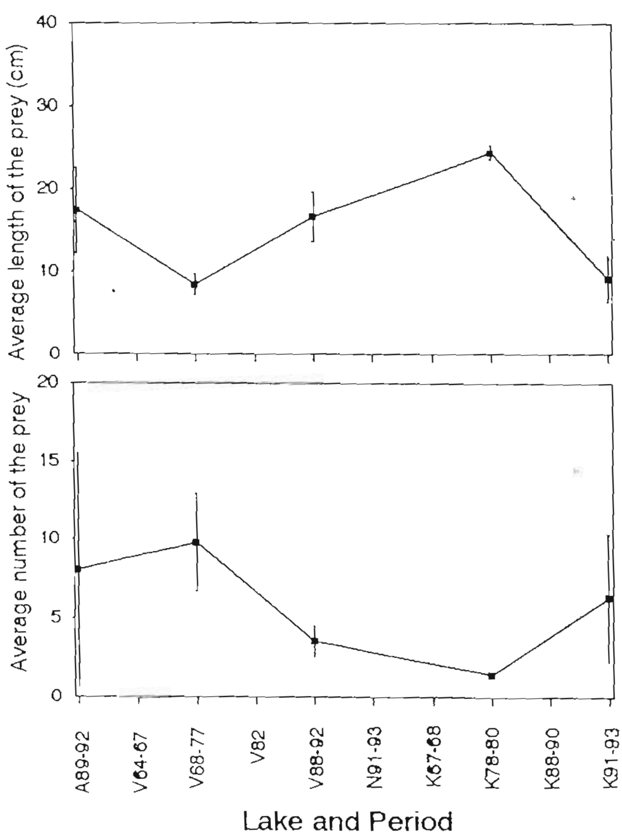

Fig. 4.3.4. The average number of prey eaten by Nile perch of >100 cm during different periods.

1992 period are close to those of different periods of Lake Kyoga between 1967 and 1993 and Lake Albert from 1989 to 1992. They are also similar to those recorded previously from Lakes Albert (Worthington 1929) and Turkana (Hopson 1982).

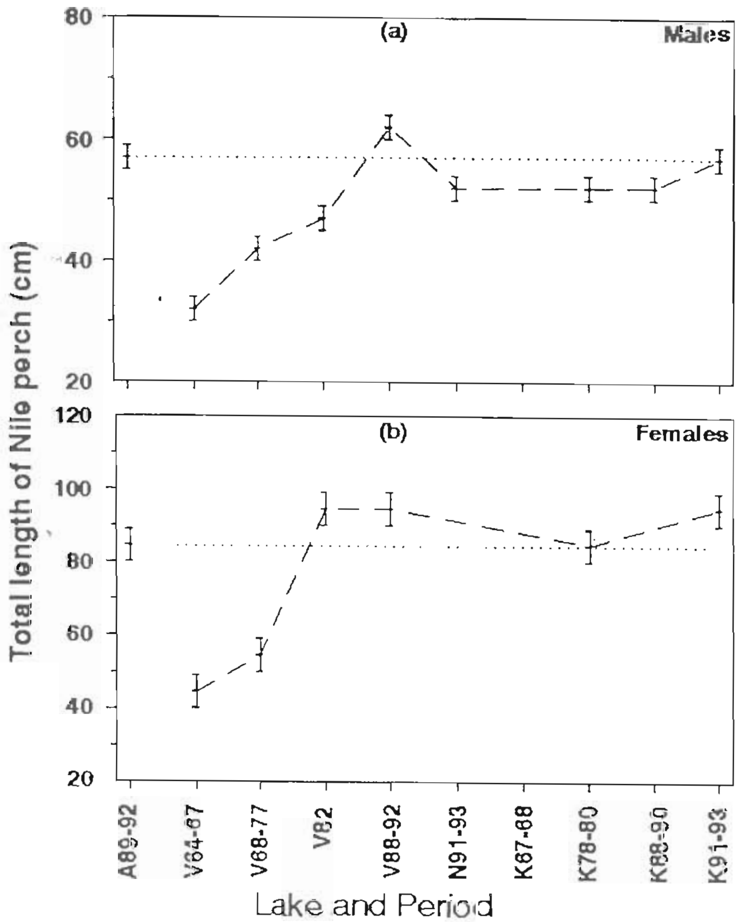

Fig. 4.3.6. Size at first maturity of (a) males and (b) female Nile perch in different lakes examined during different periods.

The size at first maturity of female Nile perch in Lake Victoria was 40 to 59 cm total length between 1964 and 1977 (Fig. 4.3.6b) and was 90 cm to 99 cm between 1988 and 1992. The sizes at first maturity of female Nile perch in Lake Kyoga between 1967 and 1993, Lake Nabugabo between 1991-1993 and Lake Albert between 1989 and 1993 were 80 cm to 100 cm total length. It should be noted that the size at first maturity among females is close to the size at which *L. niloticus* shifts to larger prey (Hopson, 1972; Ogutu-Ohwayo, 1985, 1994). Consumption of larger prey could be related to a need to increase the energy input required for reproduction.

Initially Nile perch in the new habitats matured at a smaller size than in its original habitat of Lake Albert. The size at first maturity in the new habitats adjusted over time to values recorded in Lakes Albert and Turkana (Holden 1963; Hopson 1982) but higher than those recorded in Lake Chad and the Blue Nile (Hopson 1972; Kenchington 1939). These differences in size at first maturity could be due to differences in environmental conditions and fishing pressure. Maturity at a smaller size seems to occur in fish, which are in good condition, and has also been reported when there is over-exploitation. Nile perch in lakes where the condition factor was higher matured at a smaller size than where it was lower (Kenchington 1939; Gee 1969).

Sex ratios

Differences in sex ratios of Nile perch have been observed between native and new habitats (Okedi 1971; Kenchington 1939). The sex ratios of mature Nile perch over different periods are shown in Fig. 4.3.7. The proportion of mature females in Lake Victoria was significantly higher than in Lake Albert between 1964 and 1977. The proportion of mature females in Lake Victoria by 1982 and in Lakes Kyoga and Nabugabo was significantly lower than that for Lake Albert. This indicates that Nile perch now has less capacity to replace its stocks. The 1995-2001 data for Lake Victoria gave 20 mature males per 100 mature females.

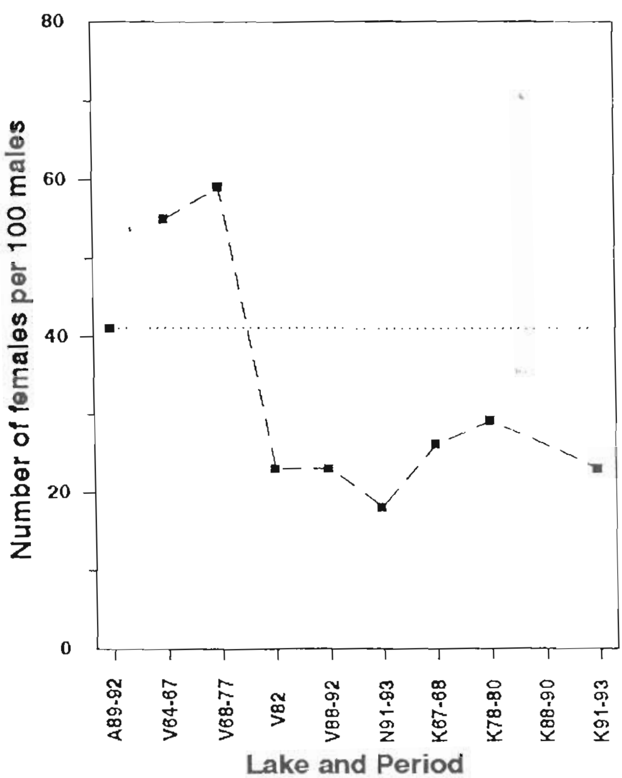

Fig. 4.3.7. Sex ratios of mature females to mature males in the lakes examined during the different periods.

Inter-habitat comparisons of sex ratio suggest a preponderance of males over females when all sizes of fish are considered. However, there have been significant changes in sex ratios in the new habitats since the Nile perch was introduced. In all the cases, the proportion of females in the population has decreased over time and is significantly lower than observations in native habitats including Lake Albert. These changes could be related to ecosystem pressures especially the reduction in the abundance of prey. Ricklefs (1990) noted that a reduction in food supply can cause sex ratios to be biased towards one sex. The sex, which requires less energy, is produced in greater proportion under a situation of food scarcity. More energy may be required to produce females than males due to the higher energy required to produce ova. Also over-exploitation of the larger individuals would affect the proportion of mature females in the population since the females mature at a larger size than males.

Fecundity

Lates niloticus is very fecund. Fecundity increases with length and weight of the fish and is proportional to the cube of the length. Since fecundity increases with size, maturity at a larger size is advantageous as it increases the number of eggs produced. This is probably one of the reasons why females grow to a much larger size than the males (Worthington 1929; Kenchington1939. Hopson 1972, 1982). Delay in maturity to a larger size could be an adaptation to gain fecundity under a situation of food shortage (Stearns & Crandall, 1989). High fecundity is also beneficial in cannibalistic species like Nile perch because if the stocks of a cannibal have to be sustained, enough young have to be produced to sustain the stocks. The extreme bias of sex ratio towards males like that recorded in Lake Victoria between 1988 and 1992 and that in all other native habitats will lower total fecundity (the total number of eggs produced by all females in the population) and this will affect the capacity of the species to replenish its stocks.

Conclusions and Recommendations

The reduction in the prey supply in the new habitats, the decrease in average weight of the Nile perch and the male biased population suggest that Nile perch has less capacity to replenish its stocks and the very high Nile perch yields realized soon after its establishment in Lakes Victoria and Kyoga may not be sustained if suitable management measures are not instituted. This situation is compounded by the very high fishing pressure on the species due to the very high demand for fish by the increasing human population and the export oriented fish processing plants. The increase of fish catches following establishment of Nile perch resulted in establishment of fish processing plants which fillet Nile perch mainly for export and this has stimulated increases in fishing effort. In the Ugandan part of Lake Victoria, fishing effort increased from 3,200 canoes in 1972 before the establishment of Nile perch to 8,674 canoes in 1990 to 15,462 canoes by 2000. The total number of boats on the lake is now 41,000. This rapid increase in fishing effort is a major threat to the fishery. In addition, over-fishing of *R. argentea* without a compensatory recovery in haplochromine stocks would further endanger the Nile perch stocks. For the Nile perch fishery to remain sustainable, it will be necessary to: avoid catching immature males and females; avoid exploitation of Nile perch prey especially *R. argentea* and the prawns (*C. nilotica*); protect females; and reduce fishing pressure to allow fish to attain larger sizes.

Female Nile perch mature at and grow to larger sizes than males. Analysis of the population structure of mature Nile perch shows that virtually all fish above 120 cm total length are females. Management of the Nile perch fishery should, besides protecting immature males and females to enable them reach breeding size aim at protecting mature females so that there can be enough females to produce eggs to replenish the stocks. Males mature at a smaller size 50-55 cm and this should determine the lower size limit of Nile perch that should be harvested. Hence Nile perch of less than 50cm should not be harvested and mature females of >100cm should be protected. This means harvesting of Nile perch should be restricted to fish within the 50 to 100 cm length range.

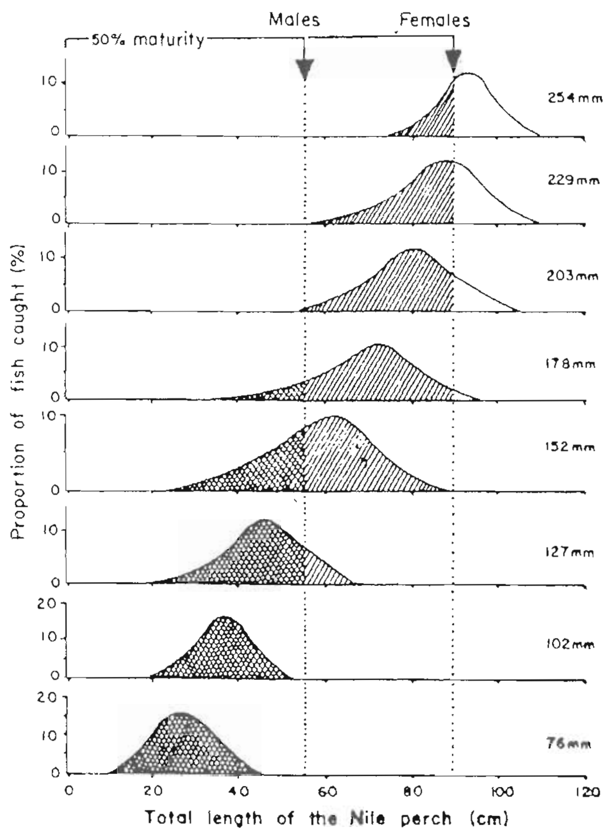

Fig. 4.3.8. Smoothed curves of length frequency distribution of Nile perch caught in nets of 76 mm to 254 mm.

Gill nets and hooks are the main legal fishing gear used to harvest Nile perch. Gill net selectivity for Nile perch (Fig. 4.3.8) shows that the mesh size of gill net that catch Nile perch of 50 cm is 5 inches (127 mm) stretched mesh while that required to catch Nile perch of 100 cm is 10 inches (254 mm) mesh. The mesh size of gill nets on Lake Victoria should be restricted to nets of 127 mm (5 inches) and 254 mm (10 inches).